CERTIFICATION

I, Junji Morimoto; Twin 21 MID Tower 34F 1-61, Shiromi 2-chome Chuo-ku, Osaka 540-6134, Japan, hereby certify that I am the translator of the accompanying certified official copy of the document in respect of an application for a patent filed in Japan on the 6th day of March 2001 and application number is 2001-62478, and certify that the following is a true and correct translation to the best of my knowledge and belief.

Junji Morimoto

Junji Morimoto

Dated this 15th day of February 2006

[Document Name] Patent application

[File Number] F2D11217

[Filing Date] March 6, 2001

[Addressed to] Honorable Commissioner of Patent Office

[International Patent Classification] F16H 48/20

[Inventor]

[Address] c/o KANZAKI KOKYUKOKI MFG. CO., LTD.
2-18-1 Inadera, Amagasaki-shi, Hyogo

[Name] INOUE Toru

[Inventor]

[Address] c/o KANZAKI KOKYUKOKI MFG. CO., LTD.
2-18-1 Inadera, Amagasaki-shi, Hyogo

[Name] HASEGAWA Toshiyuki

[Applicant]

[Discrimination Number] 000125853

[Address] 2-18-1 Inadera, Amagasaki-shi, Hyogo

[Name of the company] KANZAKI KOKYUKOKI MFG. CO., LTD.

[Representative Director] YAMAOKA Kojiro

[Attorney]

[Discrimination Number] 100080621

[Patent Attorney]

[Name] YANO Juichiro

[Telephone] 06-6261-3047

[Indication of the Fee]

[Fee file number] 001890

[an amount of fee] 21000

[Attachment]

[Name] Specification 1

[Name] Drawing 1

[Name] Abstract 1

[Document Name] Specification

[Title of the Invention]Transmission of Working Vehicle

[Claims]-

[Claim 1] A transmission of a working vehicle, comprising:

left and right axles;

axle housings for the respective axles;

a transmission casing joined to the axle housings in respective jointing spaces;

a differential locking slider for selectively put the left and right axles into either a differential connection state or a direct connection state;

a friction disc mounted on any of the axles; and

a pressure plate for braking the friction disc, wherein the differential locking slider and the pressure plate are disposed coaxially to each other in the jointing space for joining the transmission casing to one of the axle housings.

[Claim 2] The transmission of a working vehicle as set forth in claim 1, further comprising:

a flanged portion formed on an outside wall of the transmission casing so as to be joined to the axle hosing;

a guide portion provided inside the flanged portion so as to axially slidably support the pressure plate, wherein the differential locking slider is disposed in the guide portion; and

a partly cut-off peripheral wall of the guide portion, wherein an arm for operating the differential locking slider is inserted through the cut-off portion.

[Claim 3] The transmission of a working vehicle as set forth in claim 2, further comprising:

a brake control shaft supported by the axle housing and adapted for rotating the pressure plate which is rotatable along the peripheral wall of the

guide portion; and

a cam member supported around the peripheral wall of the guide portion so as to thrust the pressure plate in correspondence to a rotational degree of the pressure plate.

[Claim 4] The transmission of a working vehicle as set forth in claim 3, wherein the arm for operating the differential locking slider is disposed so as to have a rotational axis offset from a virtual plane containing a rotational axis of the pressure plate, and wherein the brake control shaft is placed in parallel to the left and right axles on the opposite side to the arm with respect to the virtual plane.

[Claim 5] The transmission of a working vehicle as set forth in claim 1, further comprising:

an input shaft projecting outward from one of the left and right sides of the transmission casing; and

a driven pulley constituting a belt-type continuously variable transmission disposed onto an outward projecting portion of the input shaft, wherein the differential locking slider is disposed nearer to the other right or left side of the transmission casing.

[Detailed Description of the Invention]

[0001]

[Technical field to which the invention belongs]

The present invention relates to a transmission of a working vehicle. Particularly it relates to a technology for compacting the transmission with a differential locking mechanism.

[0002]

[Prior Art]

A conventional transmission with a differential locking mechanism supports a differential locking operation arm in parallel to axles. A fork is fixed on the differential locking operation arm and engages with the

differential locking slider. By sliding the differential locking operation arm, the differential locking slider slides together with the differential locking operation arm so as to put the axles into either a differential connection state or a direct connection state.

[0003]

[Problem to Be Solved by the Invention]

However, in the conventional structure, the fork engaging with the differential locking slider tends to be large and hinders the transmission from being compact.

Further, a large space is required in the transmission housing so as to ensure a sufficient reciprocal axial slide range of the large fork, thereby also causing difficulty in compacting the transmission.

[0004]

[Means for Solving the Problem]

The problem to be solved by the invention has been mentioned as the above. Description will now be given to manners for solving the problem.

[0005]

As claimed in claim 1, in a transmission of a working vehicle comprising: left and right axles; axle housings for the respective axles; a transmission casing joined to the axle housings in respective jointing spaces; a differential locking slider for selectively put the left and right axles into either a differential connection state or a direct connection state; a friction disc mounted on any of the axles; and a pressure plate for braking the friction disc, the differential locking slider and the pressure plate are disposed coaxially to each other in the jointing space for joining the transmission casing to one of the axle housings.

[0006]

As claimed in claim 2, a flanged portion is formed on an outside wall of the transmission casing so as to be joined to the axle hosing, the differential

locking slider is disposed in a guide portion provided inside the flanged portion so as to axially slidably support the pressure plate, and a peripheral wall of the guide portion is partly cut off so that an arm for operating the differential locking slider is inserted through the cut-off portion.

[0007]

As claimed in claim 3, a brake control shaft is supported by the axle housing and adapted for rotating the pressure plate which is rotatable along the peripheral wall of the guide portion, and a cam member is supported around the peripheral wall of the guide portion so as to thrust the pressure plate in correspondence to a rotational degree of the pressure plate.

[0008]

As claimed in claim 4, the arm for operating the differential locking slider is disposed so as to have a rotational axis offset from a virtual plane containing a rotational axis of the pressure plate, and the brake control shaft is placed in parallel to the left and right axles on the opposite side to the arm with respect to the virtual plane.

[0009]

As claimed in claim 5, an input shaft projects outward from one of the left and right sides of the transmission casing, a driven pulley constituting a belt-type continuously variable transmission is disposed onto an outward projecting portion of the input shaft, and the differential locking slider is disposed nearer to the other right or left side of the transmission casing.

[0010]

[Embodiment of the Invention]

An embodiment of the invention will now be described.

Fig. 1 is a side view of an entire truck with a transmission according to the present invention.

[0011]

A general structure of the truck as an embodiment of the present

invention will be described with reference to Fig. 1.

A bodywork frame 10 is disposed in the longitudinal direction of the vehicle. An engine 3 is mounted on the bodywork frame 10 at a position downwardly rearward of an operator's seat 2. The engine 3 is disposed so as to make its crankshaft 6 horizontal.

At the rear of the engine 3, a transmission 4 of the present invention is supported by the bodywork frame 10 through a pair of axle housings 18 (described below). A pair of left and right slender flat boards are disposed in the longitudinal direction of the vehicle and parallel to each other, and the rear end portion of the flat boards are connected with each other, thereby forming the bodywork frame 10 having a U-shape in a plan view. As shown in Fig. 2, the axle housings 18 are fixed onto the bodywork frame 10 such that a housing 31 of the transmission 4 is located between the left and right flat boards.

A cargo deck frame l0a on which a cargo is mounted is disposed above the transmission 4 and the engine 3, and is supported by the bodywork frame 10.

[0012]

An input shaft 5 of the transmission 4 projects either leftward or rightward from the transmission casing 31. The input shaft 5 is connected to the output shaft 6 of the engine 3 through a belt-type automatically continuous variable transmission (hereinafter referred to as “CVT”) 7. A pair of left and right rear axles 8 project outward from both left and right sides of the transmission casing 31. Each of rear wheels 9 as drive wheels is provided on the outer end of each of the rear axles 8.

A front axle casing (not shown) is supported at a front portion of the vehicle. The front axle casing houses a pair of left and right front axles 11, and a differential (not shown) differentially connecting the front axles 11 with each other. Each of the front axles 11 supports each of front wheels 12 at its

outer end. The front wheels 12 are steerable by a steering wheel 13 projecting in front of the operator's seat 2.

[0013]

A travel direction switching lever 19, which is operated to select whether the travel direction of the vehicle is forward or backward, is disposed on a side of the steering wheel 13. A speed-changing pedal 21 is provided in front of the operator's seat 2, and is linked with a throttle valve (not shown) which adjusts the volume of injected fuel. By changing the degree of opening of the throttle valve according to degree of depressing of the speed-changing pedal 21, the output speed of the engine 3 can be increased or reduced.

The power is transmitted from the output shaft 6 to the input shaft 5 of the transmission 4 through the CVT 7, and transmitted into the transmission casing 31 through the input shaft 5. The power passes through a power train in the transmission casing 31, and is finally transmitted to the rear wheels 9 through the rear axles 8, thereby driving the truck 1.

A pair of brake devices 22 for braking the respective axles 8 are provided in the transmission casing 31. Each of the brake devices 22 is operable by each of a pair of brake control arms 23 rotatably supported on the respective left and right outside walls of the axle housings 18. The brake control levers 23 are interlocked with a single brake pedal (not shown) disposed in the vicinity of the speed-changing pedal 21, such that the left and right rear axles 8 are braked at the same time by depressing the brake pedal.

[0014]

Next, description will be given on the interior structure of the transmission 4 equipped on the truck 1 constructed as the above in accordance with the drawings from Fig. 2 on.

Fig. 2 is a sectional rear development of the transmission; and Fig. 3 is a perspective view of the transmission from the axle housings are detached.

Fig. 4 is a sectional rear development mainly showing the structure of a clutch fork shaft and an idle gear; Fig. 5 is a sectional side view showing a structure that a differential shift am is inserted through a partly notched portion of the guide portion; and Fig. 6 is a sectional side view mainly showing the structure of a forward/backward travel direction-switching shaft.

Fig. 7 is a perspective view of a right housing member composing the transmission casing; Fig. 8 is a perspective view of a pressure plate; Fig. 9 is a sectional plan development showing brake control shafts; and Fig. 10 is a sectional rear view showing a structure for leading lubricating oil to an output shaft.

[0015]

As shown in Fig. 2, the transmission casing 31, which houses the transmission 4, is formed by joining a left housing 31L and a right housing to each other at their vertical flat and peripheral joint faces. Inside the joined portions of transmission casing 31 are disposed the left and right rear axles 8, a differential 32 differentially connecting the left and right rear axles 8, and a forward/backward travel direction switching mechanism 35 operated by the forward/backward travel direction switching lever 19, and so on.

Further, as shown in Figs. 2 and 3, left and right housings 31L and 31R are formed at outer walls thereof with respective outwardly extended cylindrical joint flanges 31La and 31Ra. Outer end surfaces of the joint flanges 31La and 31Ra are vertical and flat surfaces to which respective axle housings 18 are joined.

[0016]

The input shaft 5 is laterally and rotatably supported at a vertical intermediate portion of the transmission casing 31. One end of the input shaft 5 projects laterally outward from one side surface of the transmission casing 31. A split driven pulley 36 is provided on the outward projecting portion of the input shaft 5, such that the driven pulley 36 serves as an output

section of the above-mentioned CVT 7.

The CVT 7, as usual, is automatically steplessly shifted to reduce the deceleration ratio thereof according to increase of the rotary speed of the engine 3. The CVT 7 may be replaced with any other stepless variable transmission than the belt-type transmission. For example, a hydrostatic stepless transmission with hydraulic pump and motor may do so.

[0017]

A governor 25 is attached onto the input shaft 5 so as to detect the rotary speed of the input shaft 5 and to adjust the fuel injection quantity of the engine corresponding to the detected rotary speed, thereby keeping the constant relation between the fuel injection quantity and the rotary speed. A vertical governor output shaft 61 is supported in the right housing 31R, as shown in Figs. 3 and 5. An input arm 62 is fixed onto an end portion of the governor output shaft 61 in the housing so as to receive the output power from the governor 25. The other end of the governor output shaft projects upwardly outward from the housing so as to be fixedly provided thereon with an unshown output arm operably connected to a throttle valve of the engine via a suitable linkage.

[0018]

The input shaft 5, serving as the primary side of the forward/backward travel direction switching mechanism 35, is notched on its periphery so as to form a forward-traveling drive gear 38 and a backward-traveling drive gear 39. A transmission shaft 41 is disposed parallel to the input shaft 5. A forward-traveling driven gear 42 and a backward-traveling driven gear 44 are relatively rotatably fitted on the transmission shaft 41.

The forward-traveling driven gear 42 meshes with the forward-traveling drive gear 38 on the input shaft 5. An idle gear 45 (shown in Fig. 4) rotatably supported in the housing meshes with the backward-traveling driven gear 44, and with the backward-traveling drive

gear 30 on the input shaft 5.

[0019]

As shown in Fig. 4, the idle gear 45 is relatively rotatably provided on a support shaft 37 supported in parallel to the input shaft 5 in the housing. The support shaft 37 is supported at one end thereof by the left housing 31L. The right housing 31R has a portion inwardly expanded from the portion thereof joined to the left housing 31L, and the other end of the support shaft 37 is inserted into a circular hole formed in a support plate 30 fixed onto the inwardly expanded portion of the right housing 31R.

Due to this structure, the support shaft 37 is supported at both sides thereof so as to reduce its deviation. Further, the housings 31L and 31R are not used at all lengths thereof in their lateral direction for supporting the support shaft 37. Therefore, the support shaft 37 becomes short so as to provide a space in which another mechanism (including the governor output shaft 61 and the input arm 62 in the present embodiment) can be disposed.

[0020]

As shown in Figs. 2 and 4, a clutch slider 47 is axially slidably and not relatively rotatably fitted on the transmission shaft 41 between the forward-traveling driven gear 42 and the backward-traveling driven gear 44. Due to the axial slide of the clutch slider 47, one of the driven gears 42 and 44 is selectively engaged with the clutch slider 47, so as to rotate the transmission shaft 41 in selected one of opposite directions. Otherwise, the clutch slider can be disposed at a neutral position where it is disengaged from both the gears 42 and 44.

[0021]

As shown in Fig. 4, a straight clutch fork shaft 48 is slidably supported in the housing. The clutch slider 47 engages with an arm 49 fixed on an intermediate portion of the clutch fork shaft 48. As show in Figs. 3 and 6, a forward/backward traveling switching control shaft 50 is supported

vertically in the right housing 31R. An arm 46 is planted into an eng portion of the control shaft 50 in the housing. A tip of the arm 46 is fitted into a groove formed in the intermediate portion of the clutch fork shaft 48, as shown in Figs. 4 and 6. An unshown sub-speed control lever is fixed on an portion of the control shaft 50 projecting outward from the housing, and interlocked with the traveling direction switching lever 20 (sic).

The lever 20 (sic) is tilted to slide the clutch slider 47 among a forward traveling position, a backward traveling position and a neutral position.

[0022]

As shown in Fig. 4, the clutch fork shaft 48 is provided with a detent mechanism 66 for holding the clutch fork shaft 48 at the selected position. The detent mechanism includes three parallel grooves 48a formed on the clutch fork shaft 48 corresponding the above-mentioned three shift positions (the forward traveling position, the backward traveling position and the neutral position). The detent mechanism also includes a detent ball 67 biased by a spring to be engaged into one of the grooves.

The clutch fork shaft 48 is provided with a switch 68 for detecting the neutral position of the clutch fork shaft 48. The engine is not allowed to start up before the clutch fork shaft 48 is detected to be disposed at the neutral position.

[0023]

As shown in Fig. 2, an output gear 51 is notched on a portion of the transmission shaft 41 toward one end thereof, so as to transmit the rotation of the transmission shaft 41 to the differential 32. The differential 32 will be described.

The differential 32, as usual, includes: a hollow differential casing 52 supported in the transmission casing 31 coaxially to the rear axles 8; an input gear 53 fixed on the differential casing 52 and meshing with the output gear

51 on the transmission shaft 41; a pinion shaft 54 integrally rotatably disposed in the differential casing 52 perpendicular to the rear axles 8; bevel pinions 55 rotatably provided on opposite ends of the pinion shaft 54, and the bevel differential side gears 56 fixed on proximal ends of the rear axles 8 in the differential casing 31 and meshing with the pinions 55.

[0024]

A differential locking device 33 for locking the differential 32 includes a differential lock slider 57 axially slidably fitted on the axle 8 opposite to the differential casing 52 with respect to the input gear 53. Lock pawls 58 are formed on a surface of the differential lock slider 57 opposite to the input gear 53. Engaging pawls 59 are formed on a boss portion of the input gear 53 so as to be able to engage with the lock pawls 58. In this construction, by sliding the differential lock slider 57, the differential locking device 33 is switched between a direct connection state, where the lock pawls 58 of the differential lock slider 57 integrally engage with the engaging pawls 59 of the input gear 53, and a differential connection state, where the lock pawls 58 of the differential lock slider 57 are disengaged from the engaging pawls 59 of the input gear 53 so as to allow the differential 32 to differentially connect the left and right axles 8.

[0025]

A vertical differential control shaft 63 is rotatably supported in the right housing 31R as shown in Figs. 3 and 5. A differential shift arm 64 is fixed on an end portion of the differential control shaft 63 extended inward in the housing. The differential shift arm 64 engages at a tip thereof with the differential lock slider 57.

A differential lock control arm 65 is fixed on a tip of the differential control shaft 63 projecting outward from the housing. The differential lock control arm 65 is operably connected to the differential lock lever via a linkage and so on. The differential lock control arm 65 is tilted to

selectively lock or unlock the differential 32.

[0026]

The brake devices 22 disposed on the respective rear axles 8 are frictional disc brakes. By depressing the brake pedal, the brake control levers 23 are rotated so as to make pressure plates 60 press corresponding multi friction discs 26 against one another, thereby braking the rear axles 8.

[0027]

The structure of the disc brake devices 22 will be detailed.

As shown in Fig. 2, a boss portion of the input gear 53 is supported by an outer sidewall of the right housing 31R via a bearing, and a boss portion of the differential casing 52 is supported by an outer sidewall of the left housing 31L via a bearing. As mentioned above, the outer sidewalls of the housings 31L and 31R are laterally outwardly extended in cylindrical shapes so as to form the joint flanges 31La and 31Ra. The joint flanges 31La and 31Ra are adapted to be joined to the respective axle housings 18. The joint flanges 31La and 31Ra have inner spaces, referred to as "jointing spaces" in this description.

[0028]

In the jointing spaces, the outer sidewalls of the housings 31L and 31R are further laterally outwardly extended in circularly cylindrical shapes, so as to serve as guide portions 31Lb and 31Rb. The pressure plates 60 are rotatably and axially slidably fitted on the outer peripheral surfaces of the guide portions 31Lb and 31Rb. As shown in Fig. 8, the ring-shaped pressure plates 60 have internal diameters coinciding to external diameters of the guide portions 31Lb and 31Rb, and each of the pressure plates 60 is formed on the outer peripheral edge thereof with two projections 60a.

The differential lock slider 57 is disposed in the guide portion 31Rb of the right housing 31R.

[0029]

As shown in Figs. 2, 3, 5 and 9, brake control shafts 24 are rotatably supported in parallel to the axles 8 above the respective left and right pressure plates 60 and adjacent to the respective pressure plates 60. Each of the brake control shafts 24 is fitted at one end thereof into a boss portion 73 formed on the sidewall of each of the left and right housings 31L and 31R. The other end of each brake control shaft 24 is supported by a sidewall of the axle housing 18, and projects laterally outward from the axle housing 18, so as to be fixedly provided thereon with the brake control lever 23.

For example, each of the brake control shafts 24 is shaped into a semicircular cam at a portion facing one of the two projections 60a of the corresponding pressure plate 60, as shown in Fig. 5. Due to this construction, when the brake control shaft 24 is rotated by rotating the brake control lever 23, the cam pushes the projection 60a so as to rotate the pressure plate 60 along the peripheral surface of each of the guide portions 31Lb and 31Rb.

[0030]

As shown in Fig. 2, a plurality of depressions, each of which is formed into a hemispherical shape, are arranged at regular intervals in circumference on the side wall of the left housing 31L at the outside of the guide portion 31Lb. As shown in Figs. 2 and 5, a plurality of cam holding portions 70 project from the outer peripheral surface of the guide portion 31Rb of the right housing 31R at regular intervals in the peripheral direction in correspondence to the above-mentioned respective depressions. A hemispherical depression is formed on each of the cam holding portions 70.

In correspondence to the positions of the depressions, a plurality of depressions 60b are formed and arranged at regular intervals in circumference on one side face of the pressure plate 60, as shown in Fig. 8. Each of the depressions 93b, formed in a substantially lozenge shape, has the greatest depth at a center portion in circumference, and becomes shallower toward the ends thereof in circumference.

A steel ball 69, serving as a cam member, is held in each of the hemispherical depressions of each of the left and right housings 31L and 31R, and the pressure plate 60 is fitted on the outer peripheral surface of each of the guide portions 31Lb and 31Rb, such that each of the steel balls 69 is fitted into each of the depressions 60b. The multi friction discs 26 are disposed between the other side face of the pressure plate 60 opposite to the depressions 60b and the inner sidewall of the axle housing 18. The multi friction discs 26 include first friction discs and second friction discs, which are alternately layered. The first friction discs are engaged to each of the rear axles 8, and the second friction discs are engaged to the inner sidewall of the axle housing 18.

In this structure, when the pressure plates 60 are rotated along the respective outer peripheral surfaces of the guide portions 31Lb and 31Rb by the operation of brake control arm 23, each of the pressure plates 60, onto which the cam action of the steel balls 69 is applied, gets thrust corresponding to its rotational degree, and is slidden outward, thereby pressuring the multi friction discs 26 and braking each of the rear axles 8.

[0031]

The guide portion 31Rb is formed wider than the guide portion 31Lb, and the external diameter of the differential locking slider 57 is smaller than the internal diameter of the guide portion 31Rb (namely, smaller than the internal diameter of the pressure plate 60). The differential locking slider 57 is provided inside the guide portion 31Rb, and is overlapped with the pressure plate 60 in the longitudinal direction of the rear axles 8.

In this structure, the pressure plate 60 and the differential locking slider 57 are provided in the above-mentioned “jointing space”. Since each of the guide portions 31Lb and 31Rb is cylindrically formed coaxially with the rotational axis of the rear axles 8, the rotational axis of the pressure plates 60 is substantially coaxial with an axis of the differential locking slider 57

provided on the rear axle 8.

Thus, the differential locking slider 57 and the pressure plate 60 can be compactly disposed in the jointing spaces, thereby being available for miniaturizing the transmission 4.

[0032]

As shown in Figs. 2 and 5, the differential locking slider 57 is disposed inside the guide portion 31Rb of the right housing 31R. As shown in Figs. 3 and 5, the guide portion 31Rb is partly cut off at its cylindrical wall so as to provide an opening 71. The differential shift arm 64 is inserted through the opening 71 (the cut-off portion), so as to be engaged at the tip thereof with the differential locking slider 57.

As shown in Fig. 5, the differential control shaft 63, onto which the differential shift arm 64 is fixed, is offset from a virtual plane P containing the rotational axis of the pressure plates 60. Therefore, the rotational axis of the differential control shaft 63 and the rotational axis of the differential shift arm 64 are disposed in skewed direction with each other, and do not cross.

[0033]

Therefore, the differential locking slider 57 can be slidden depending on the rotation of the differential control shaft 63 and the differential shift arm 64. The only small space needed for rotation of the differential shift arm 64 is sufficient for operating the differential locking slider 57 in the transmission casing 31.

In a conventional structure for axially sliding a differential locking slider engaged with a differential shift fork, a large space is needed for shifting the differential shift fork, thereby inhibiting miniaturization of the transmission. The above-mentioned present structure solves this problem.

[0034]

In this embodiment, the brake control shaft 24 is placed on the opposite side to the differential control shaft 63 with the virtual plane P

between. By this layout, a differential-locking operating system and a brake operating system can be disposed in a compact mass, and also can avoid interruptions with each other.

[0035]

As shown in Fig. 2, the cylindrical flanged portion 31Ra and the guide portion 31Rb of the right housing 31R are formed wider than the portions 31La and 31Lb of the left housing 31L, because the differential locking slider 57 is disposed in the guide portion 31Rb. As shown in Figs. 3 and 5, the neutral-detecting switch 68, the differential control shaft 63, and a breather cap 16 for bleeding of air are disposed at the widely-formed cylindrical flanged portion 31Ra, thereby achieving the rational layout for miniaturization of the transmission 4.

[0036]

In this embodiment, each of the axle housings 18 is formed symmetrically in the fore-and-aft direction with respect to the virtual vertical plane including the axis of the rear axles 8. Thus, two members of uniform shape can be used for both of left and right axle housings 18, thereby reducing their manufacturing costs.

Furthermore, a pair of front and rear holes, formed on side walls of the respective axle housings 18, are arranged symmetrically with respect to above-mentioned virtual vertical plane. In the structure that the axle housings 18 are disposed left and right, each of the front holes supports each of left and right brake control shafts 24, and each of the rear holes is covered by a cap 86 (see Fig. 3). Thus, the left and right brake control shafts 96 can be coaxially disposed, and left and right brake systems can be rationally symmetrically arranged.

Furthermore, two projections 60a, formed on each of the pressure plates 60, are arranged symmetrically as shown in Fig. 8. Thus, two members of uniform shape can be used for both of left and right pressure

plates 60, thereby reducing variation of parts.

[0037]

Next, the structure for lubrication of the transmission will be described.

The transmission casing 31 is filled with lubricating oil in established amount, and an oil level OL is determined as shown in Fig. 6. In this state, when the transmission is driven and the input gear 53 and so on rotate in the direction marked by a bold arrow in Fig. 6, oil is splashed onto the input shaft 5 and the transmission shaft 41, which are disposed upwardly slantwise from the input gear 53.

As shown in Figs. 6 and 10, a trough portion 75, having a V-shape in side view, is extended from a ceiling surface of the right housing 31R. A horizontal oil-leading hole 76 is formed in an inner wall of the right housing 31R facing an inner bottom of the trough portion 75. The oil-leading hole 76 communicates with a connecting hole 77, which is formed vertically in a wall of the right housing 31R. The connecting hole 77 is connected with a groove 78, which is formed in the boss portion of the right housing 31R for supporting one end of the transmission shaft 41.

In this structure, a part of the splashes of oil by rotation of the input gear 53 etc. reaches above the V-like shaped trough portion 75, and flows to the groove 78 through the oil-leading hole 76 and the connecting hole 77, thereby lubricating the bearing supporting the transmission shaft 41. A part of the oil flows through an oil supply path (designated by a reference numeral 87 in Fig. 4) axially bored in the transmission shaft 41, and lubricates the surface thereof journaling the driven gears 43 and 44, a portion engaged with the clutch slider 47, and so on.

[0038]

As shown in Figs. 6 and 10, a lubricating inlet 82 for feeding oil into the transmission casing is disposed just above the V-like shaped trough

portion 75. Therefore, when a cap 20 is taken off and lubricating oil is run in through the lubricating inlet 82, all the lubricating oil falls into the trough portion 75. A part amount of the lubricating oil can surely reach the groove 78 through the oil-leading hole 76 and the connecting hole 77, and can lubricate the bearing supporting the transmission shaft 41 and so on.

In this structure, even if components (e.g. the bearings for supporting the transmission shaft 41, the driven gears 43 and 44, the clutch slider 47) are not spread with the lubricating oil in advance of assembling the transmission, these components are surely lubricated by only running the oil in through the lubricating inlet 82 after assembling the transmission. Therefore, the number of man-hours for manufacturing can be reduced.

[0039]

A hole 81, bored in a bottom portion of the outer sidewall of the right housing 31R as shown in Fig. 13, is provided for circulating the oil. Oil can circulate through the hole 81 between an inner space of the housings 31L and 31R and an inner space of the right axle housing 18.

Further, two holes 79 and 80, bored in a top portion of the other sidewall of the right housing member 31R, is provided for circulate air between the inner space of the housings 31L and 31R and the inner space of the right axle housing 18. Therefore, the air in the right axle housing 18 can be exhaled from the breather cap 72.

Similar holes (not shown) are bored in the outer sidewall of the left housing 31L so as to circulate oil and air between the inner space thereof and an inner space of the left axle housing 18.

[0040]

As shown in Fig. 5, the breather cap 72 is disposed at the ceiling surface of the right housing 31R. An opening portion 83 for installing the breather cap 72 is separated off by an inner wall 84 from the inner space of the housings 31L and 31R, but it is connected to the inner space through a small

hole 85 bored in the inner wall 84. In this structure, the air in the housings 31L and 31R can communicate with the atmosphere through the small hole 85 and the breather cap 72. Even if the lubricating oil filled in the housings 31L and 31R is stirred and splashed around, a splash of the oil is blocked by the inner wall 84 before reaching the breather cap 72, thereby preventing oil-leak from the breather cap 72.

[0041]

The invention is not limited to the above embodiment. The invention is broadly defined within the whole of a technological scope clarified from the present description and drawings, at which the invention truly aims.

[0042]

[Effect of the Invention]

The invention constructed as the above has the following effects:

According to claim 1, in a transmission of a working vehicle comprising: left and right axles; axle housings for the respective axles; a transmission casing joined to the axle housings in respective jointing spaces; a differential locking slider for selectively put the left and right axles into either a differential connection state or a direct connection state; a friction disc mounted on any of the axles; and a pressure plate for braking the friction disc, the differential locking slider and the pressure plate are disposed coaxially to each other in the jointing space for joining the transmission casing to one of the axle housings.

Therefore, the differential lock slider and the pressure plate are compactly disposed in the jointing space in the longitudinal direction of the axles, thereby being available for miniaturization of the transmission.

[0043]

According to claim 2, a flanged portion is formed on an outside wall of the transmission casing so as to be joined to the axle hosing, the differential locking slider is disposed in a guide portion provided inside the flanged

portion so as to axially slidably support the pressure plate, and a peripheral wall of the guide portion is partly cut off so that an arm for operating the differential locking slider is inserted through the cut-off portion.

Therefore, the guide portion supports and guides the pressure plate, and incorporates the differential locking slider. Namely, the pressure plate and the differential locking slider are compactly distributed between the outside and inside of the guide portion.

Further, a structure for sliding the differential locking slider disposed inside the guide portion by an external operation outside the guide portion can be easily achieved by partly cutting-off the peripheral wall of the guide portion and inserting the arm through the cut-off portion.

[0044]

According to claim 3, a brake control shaft is supported by the axle housing and adapted for rotating the pressure plate which is rotatable along the peripheral wall of the guide portion, and a cam member is supported around the peripheral wall of the guide portion so as to thrust the pressure plate in correspondence to a rotational degree of the pressure plate.

Therefore, a peripheral surface of the peripheral wall of the guide portion guides the rotation of the pressure plate therealong, thereby needing no additional special structure for centering the pressure plate.

Further, the holding of the cam member around the peripheral wall of the guide portion provides a compact structure for rotating and axially sliding the pressure plate for pressing the friction disc.

[0045]

According to claim 4, the arm for operating the differential locking slider is disposed so as to have a rotational axis offset from a virtual plane containing a rotational axis of the pressure plate, and the brake control shaft is placed in parallel to the left and right axles on the opposite side to the arm with respect to the virtual plane.

Therefore, the differential locking control system and the braking control system are compactly distributed so as to be prevented from interfering with each other, thereby being available for miniaturizing the transmission.

[0046]

According to claim 5, an input shaft projects outward from one of the left and right sides of the transmission casing, a driven pulley constituting a belt-type continuously variable transmission is disposed onto an outward projecting portion of the input shaft, and the differential locking slider is disposed nearer to the other right or left side of the transmission casing.

Therefore, the differential locking slider control system can be disposed at a position where it is prevented from interfering with the belt-type automatic variable transmission, thereby being available for miniaturizing the transmission.

[Brief Description of the Drawings]

[Fig. 1]

It is a side view of an entire truck with a transmission according to the present invention.

[Fig. 2]

It is a sectional rear development of the transmission.

[Fig. 3]

It is a perspective view of the transmission from the axle housings are detached.

[Fig. 4]

It is a sectional rear development mainly showing the structure of a clutch fork shaft and an idle gear.

[Fig. 5]

It is a sectional side view showing a structure that a differential shift am is inserted through a partly notched portion of the guide portion.

[Fig. 6]

It is a sectional side view mainly showing the structure of a forward/backward travel direction-switching shaft.

[Fig. 7]

It is a perspective view of a right housing member composing the transmission casing.

[Fig. 8]

It is a perspective view of a pressure plate.

[Fig. 9]

It is a sectional plan development showing brake control shafts.

[Fig. 10]

It is a sectional rear view showing a structure for leading lubricating oil to an output shaft.

[Description of the Notations]

8 and 8	Axles
18	Axle Housing
26	(Multi) Friction Discs
31L, 31R	Transmission Casing
57	Differential Locking Slider
60	Pressure Plate

[Document Name] Abstract

[Abstract]

[Object] An object is to provide a compact transmission with a differential locking system.

[Solution] A differential locking slider 57 for selectively putting left and right axles 8 into either a differential connection state or a direct connection state, and a pressure plate 60 for braking a friction disc 26 mounted on any of the axles 8 are disposed coaxially to each other in a jointing space of between a transmission casing 31R and one of axle housings 18.

[Selected Drawing] Fig. 2